L. Jason Krutz
Dale L. Shaner

Enhanced S-Triazine Degradation and Sugar Cane Weed Control Options

Soil borne bacteria on all continents except Antarctica have developed the ability to rapidly degrade the herbicide atrazine, a phenomenon known as enhanced degradation. The unique metabolic machinery contained within atrazine-degrading bacteria often enables them to degrade other triazine herbicides, i.e., cross-adaptation.The agronomic significance of enhanced degradation is decreased herbicide persistence, which can result in reduced residual weed control. The problem of reduced residual weed control in "adapted" soils is exasperated when cross-adaptation occurs.

Reduced residual weed control with atrazine and cross-adaptation among triazine herbicides has been confirmed under Mississippi Delta corn production systems. Moreover, researchers working with corn, pineapple, and/or sugar cane in Colorado, Hawaii, Louisiana, Mississippi, Tennessee, and Texas have attributed reduced residual weed control with atrazine to enhanced degradation and not triazine resistant weed biotypes, improper application techniques, or lack of activation. These observations lead USDA-ARS scientists to 1) delineate the occurrence and physiochemical range of adapted soils from around the globe; 2) determine the impact of cultural practices on adaptation, 3) screen United States sugar cane soils for enhanced atrazine degradation; and 4) determine which triazine herbicides labeled in sugar cane are not cross-adapted with atrazine.

Enhanced atrazine degradation occurs over a broad range of soil physiochemical conditions. Adapted soils range in texture from 3 to 90% sand, 4 to 60% silt, and 3 to 56% clay, that is, all possible soil texture classes. The organic carbon content of adapted soils ranges from 0.5 to 46%, while pH levels vary from 5.1 to 8.3. Of the evaluated physiochemical properties, only acidic soil conditions, that is, pH ≤ approximately 5.4 appears to restrict bacterial adaptation.

With the exception of herbicide use history, no cultural management practice, i.e., residue management system, cropping history or soil fertility level, affects bacterial adaptation. For example, enhanced atrazine degradation occurs in at least nine crops and six crop rotation systems that rely on triazine herbicides for residual weed control. We submit, therefore, that enhanced degradation can occur in any cropping system where triazine herbicides remain a component of the weed control program, given that soil pH is greater than approximately 5.4 and the application frequency is greater than once every 4 years.

In the sugar cane belt, the soil physiochemical range is typically within that of known adapted soils, and more importantly, triazine herbicides remain an integral component of the weed control program: 70% of the acreage treated with atrazine, 19% of the acreage treated with metribuzin and 94% of all ametryn sold applied in cane. This means that enhanced atrazine degradation could occur throughout most of the sugar cane belt.

Recently, our laboratory confirmed enhanced atrazine degradation in Hawaii and Florida sugar cane soils. These soils also rapidly degraded other symmetrical triazine herbicides labeled for use in cane, including ametryn and propazine. Conversely, these adapted soils did not rapidly degrade metribuzin, a non-symmetrical triazine herbicide. Metribuzin, therefore, should provide acceptable residual weed control in sugar cane soils, even if the bacterial population rapidly degrades symmetrical triazine herbicides.

Future research is required to determine exactly how much of the sugar cane belt is affected by enhanced atrazine degradation, and what remedial strategies will be required to achieve affordable weed control in adapted soils. When enhanced pesticide degradation has occurred in other crops, one of three approaches has been used to improve pest control:

- Increase pesticide application rate and frequency
- Switch to alternative pesticides, and/or
- Integrated Pest Management (IPM), that is, utilize a combination of pest control strategies including mechanical, physical, genetic, biological, cultural, and chemical control

In the sugar cane belt, regulatory application limits, cross-adaptation among symmetrical triazine herbicides, and limited herbicide options will likely require producers to use IPM to improve weed control on adapted soils and to prevent the development of enhanced degradation on yet affected soils. Specific IPM practices for sugar cane will need to be developed collaboratively between agronomists and weed scientists.

L. Jason Krutz, United States Department of Agriculture, Agriculture Research Service, Crop Production Systems Research Unit,141 Experiment Station Road, Stoneville, MS 38776 Email: Jason.krutz@ars.usda.gov

Dale L. Shaner, United States Department of Agriculture, Agriculture Research Service, Water Management Research Unit, 2150 Centre Avenue, Fort Collins, CO 80526

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